

**SELENIUM IN THE AQUATIC
FOOD WEB IN THE NATURE
PRESERVE WETLANDS**

by

Jim Pollard

Harry Reid Center

University of Nevada, L.V.

September 16, 2008

Background

- **Partnership between UNLV (HRC/ESD) and Clark County Parks & Recreation began in 1999/2000**
- **The Nature Preserve was still somewhat conceptual and the extent of the wetlands was minimal.**







Background Continued

- **The first task that we undertook at the Harry Reid Center was to develop an Environmental Assessment for the 130 acre “Nature Center”**
- **This was part of the National Environmental Policy Act (NEPA) requirements for development undertaken on federal lands**

EA RECOMMENDATIONS

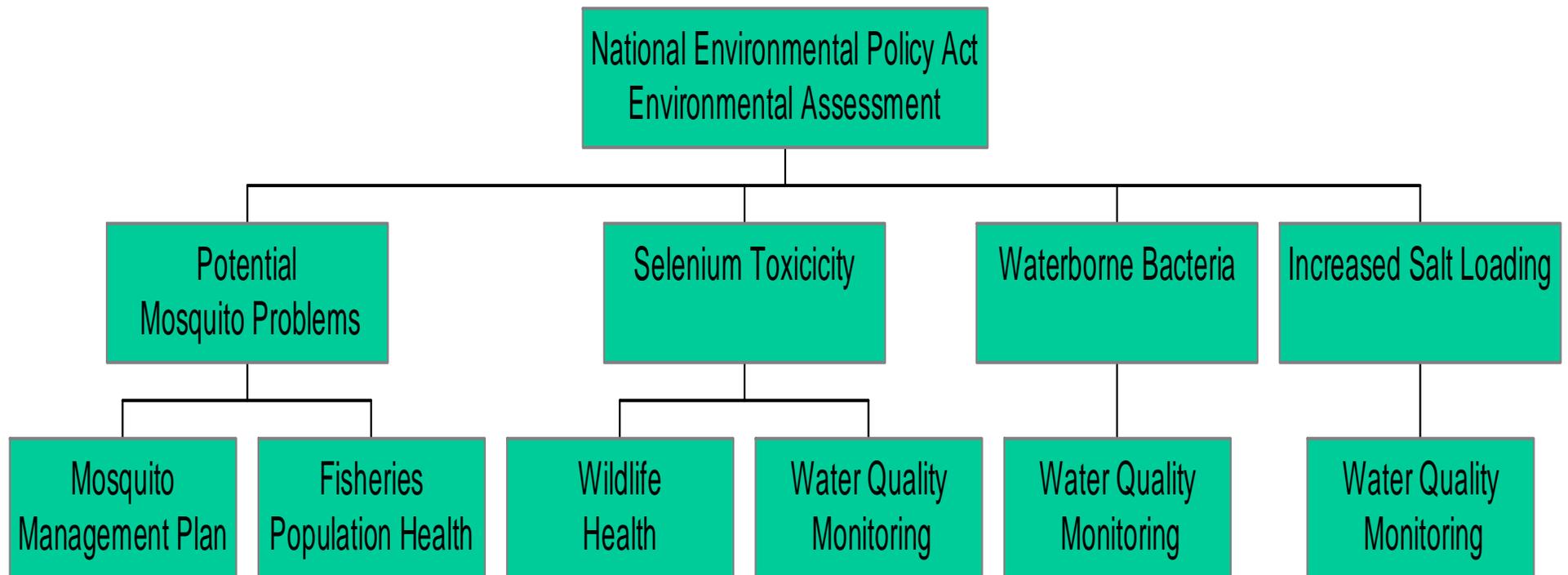
- **Threatened and Endangered Species** : May be at Risk Due to Construction Activities
- **High Selenium Concentrations** : May Exist in Source Water - Potential Wildlife Threat
- **Elevated Levels of Total Dissolved Solids** :May be Exacerbated Due to Wetlands Evaporation
- **Elevated Coliform Bacteria** : May Exist in Source Water and/or Storm Water
- **Mosquito Control** : Needs to be Planned and the Effectiveness of Control Measures Tested







Nature Preserve Projects



SELENIUM CONCERNS

- **EPA Standards** = 5 Ppb for Chronic Ambient Water Exposure, 20 Ppb for Acute (Allowable Every Three Years)
- **All Measurements** near the Nature Center System from Pre Construction Activities Indicated that the selenium levels were ~ 20 ppb in Source Water
- **Need to Assess Wildlife Threat** Using Birds, Fish and Invertebrates



Male
Mosquito fish



Female
Mosquito fish



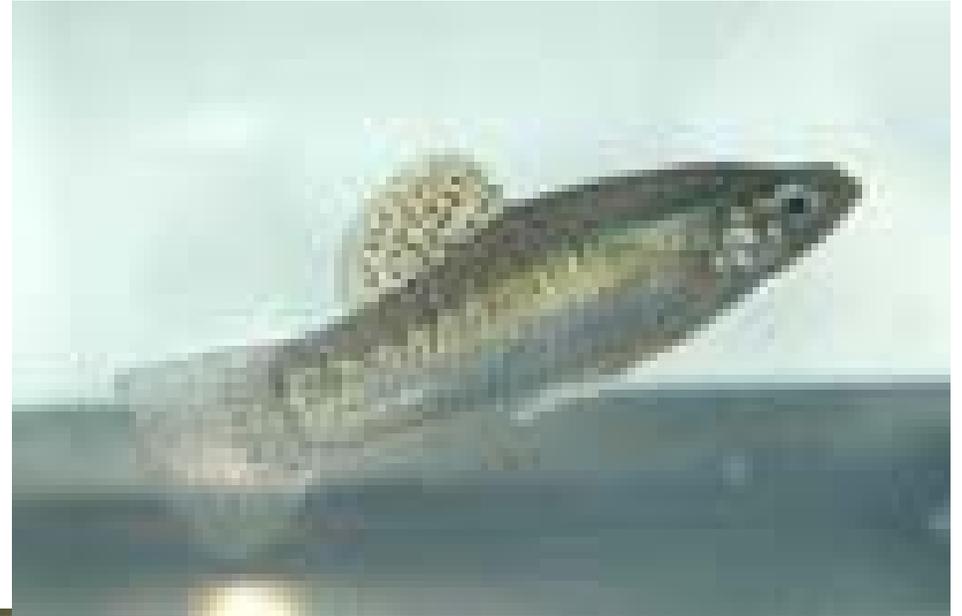
Green Sunfish



Red Shiner



Carp and Black Bullhead Catfish



Shortfin Mollie



Red Swamp Crawfish

Selenium in Water

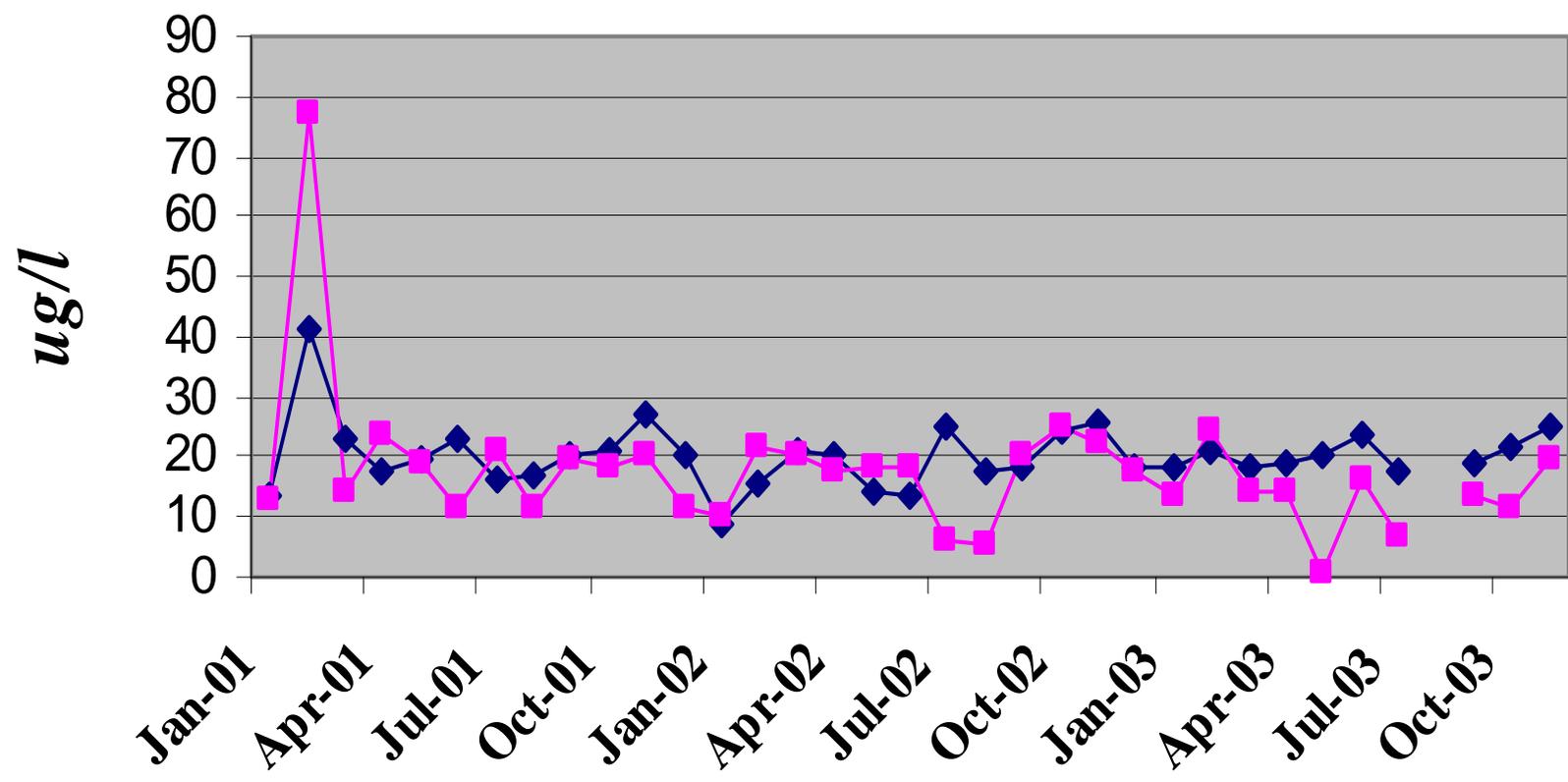
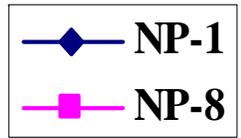
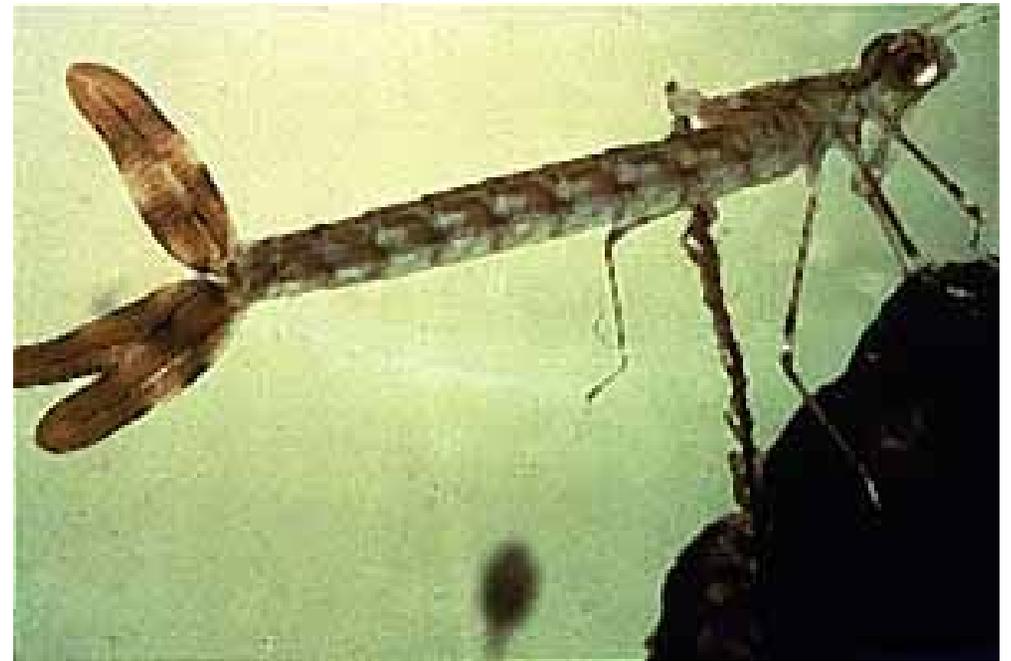


Table 1. Average selenium in parts per million dry weight for various aquatic species and pond sediments for pre-construction through the third year of operations of the Nature Preserve.

Year	Species	Average	Std. Dev.	Range	N
2000	Bullhead Catfish	26.00	--	--	1
2000	Gambusia	18.00	--	--	1
2001	Gambusia	14.81	2.27	11.2-17.2	6
2003/4	Gambusia	8.05	0.91	7.1-8.9	3
2000	Green Sunfish	22.00	11.53	13-35	3
2001	Green Sunfish	14.38	3.74	8.4-19.6	21
2003/4	Green Sunfish	20.54	8.65	12.2-36.3	12
2000	Crawfish	12.90	7.21	7.8-18	2
2001	Crawfish	4.51	1.97	2.3-7.1	6
2003/4	Crawfish	4.71	1.96	3.5-8.2	5
2004	Red Shiner	11.85	1.24	10.7-13.5	4
2000	Sediments	8.54	8.24	nd-17	5
2001	Sediments	nd	nd	nd	7
2003/4	Sediments	0.11	0.08	0.28-0.03	10



Jason Neuswanger
www.troutnut.com



Damselfly Nymphs



Net Building Caddisfly Nymphs



Dragonfly Nymphs

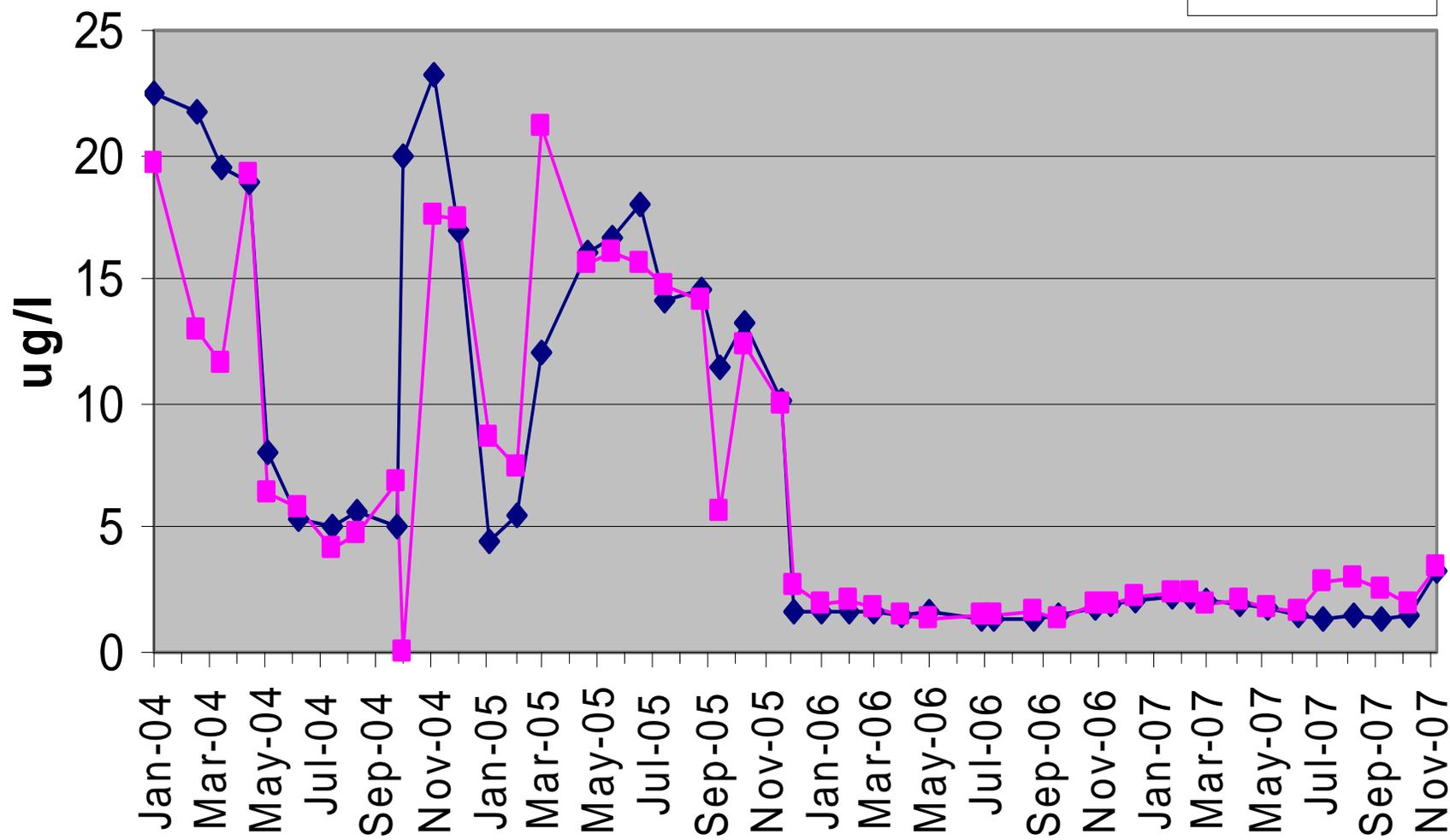
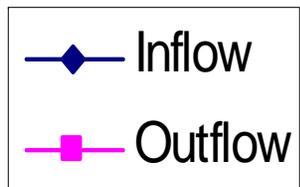




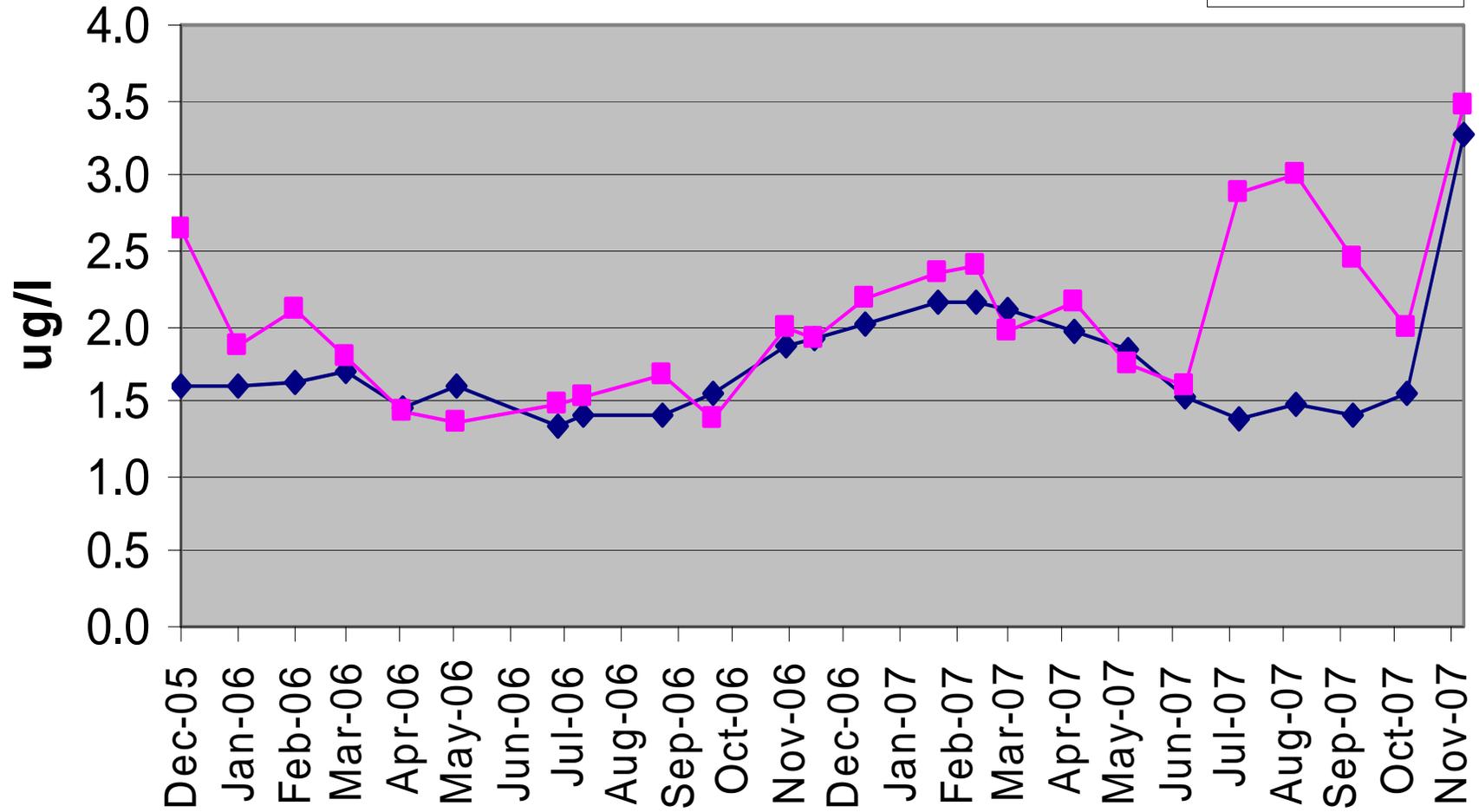
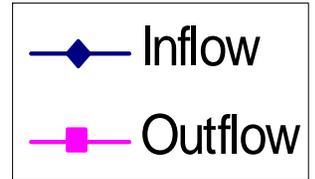
Corbicula,
Melanoides,
Physa

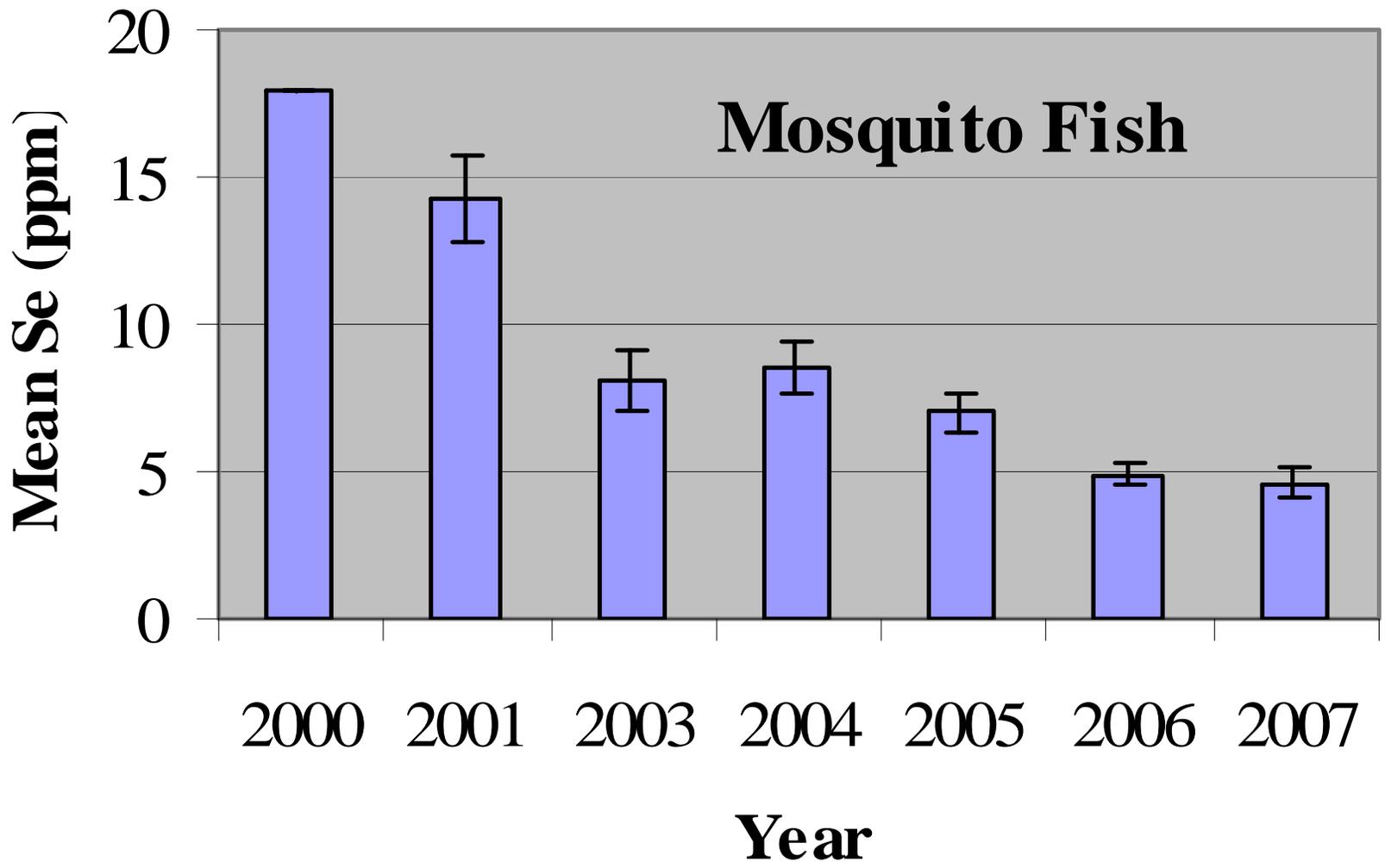


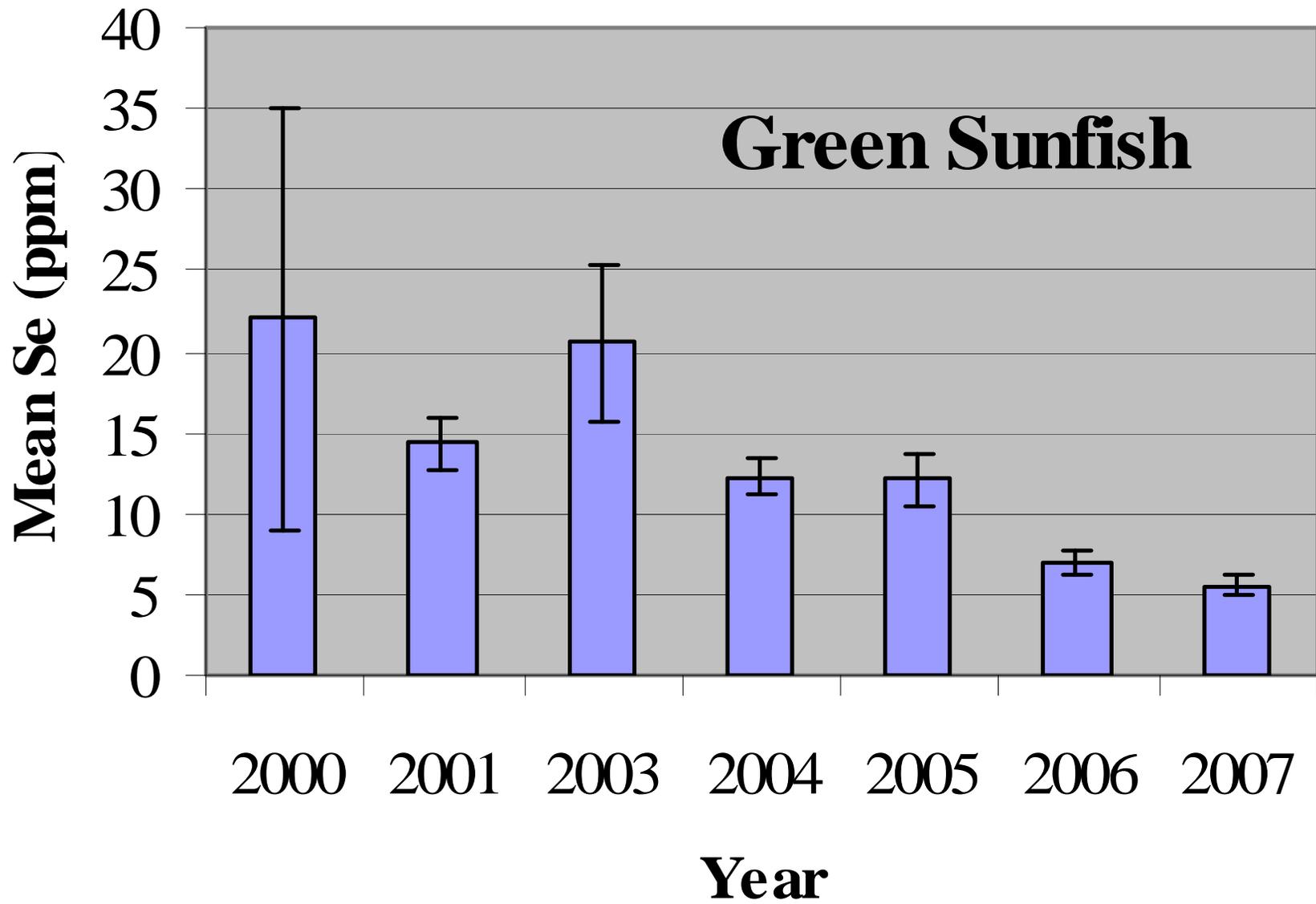
Selenium in Water

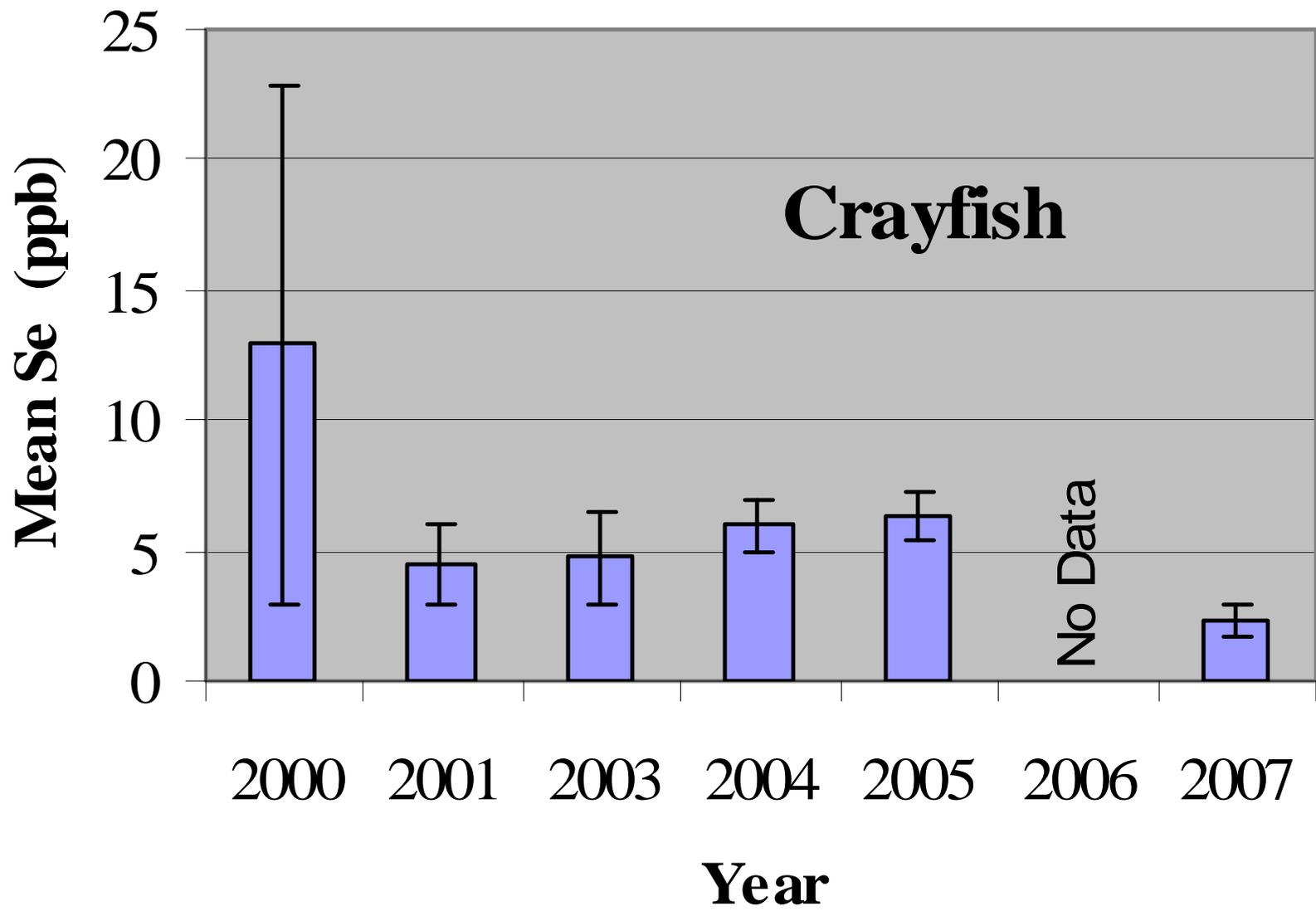


Selenium in Water









Year	Trophic Level Taxa	Mean Se	Std. Dev	Range	Number of Samples
	Scrapers				
2005	Ephemeroptera	6.94	--	--	1
	Benthic Omnivores				
2005	Juvenile crayfish	9.71	3.25	6.1-14.1	5
	Herbivores				
2005	<i>Petrophila</i> sp.	7.52	--	--	1
2005	<i>Physa</i> sp.	1.61	0.46	1.3-2.8	4
2007	<i>Physa</i> sp.	1.55	--	0.78-2.33	2
2007	<i>Melanoides</i> t.	1.23	--	--	1

Year	Trophic Level Taxa	Mean Se	Std. Dev	Range	Number of Samples
	Filter Feeders				
2005	Hydropsychidae	9.73	--	7.3-12.2	2
2006	Hydropsychidae	5.97	0.97	4.9-7.4	5
2007	Hydropsychidae	7.27	--	7.26-7.28	2
2006					
	Corbicula	1.13			1
2007					
	Corbicula	0.418			1
	Predators				
2005	Zygoptera spp	10.41	3.75	7.1-16.0	6
2006	Zygoptera spp	3.95	2.28	0.6-5.5	4
2007	Zygoptera spp	4.44	1.58	2.3-6.1	4
2005	Anisoptera sp	7.65	1.78	5.3-10.6	6
2005	Libellulidae	8.66	--	--	1

Conclusions – First three Years

- **There was a dramatic difference in sediment concentrations of selenium prior to and following construction. There was also a slight tendency for selenium to accumulate in benthic sediments after 3 years of operations. Need additional Sediment data.**
- **Aquatic species in the system had fairly high tissue burdens with fairly high field variation during the first three years of operations.**

Conclusions – First Three Years

- **Most organisms in the system were classified at substantial risk before effluent was added to the system.**
- **On the other hand, fish population observations, which included monthly census, reproductive success, and general health observations of individuals, yielded no physical evidence that would indicate toxic effects of selenium on fish.**

Conclusions – Last Four Years

- **Major declines in selenium tissue concentrations occurred when low selenium effluent replaced high selenium Monson Drain source water.**
- **All species in the system were classified as no risk or marginal risk after 2 years exposure to low selenium concentration effluent water.**
- **Continued health and census monitoring indicate a healthy, reproductive fisheries.**

Literature Comparisons - Water

- **Maier and Knight 1994, Lemly 1996, USDOJ 1998, DeForest et al 1999, and Hamilton 2004 collectively suggest that selenium levels in water at levels of 2-4 ppb should raise concern regarding potential selenium toxicity to wildlife.**
- **NP source water at the end of the study was at the low end of this range and below EPA standards.**

Literature Comparisons - Tissues

- **Tissue thresholds for adverse effects in fish presented by Hamilton (2004) were 3 ppm for diet and 4 ppm for concentration in whole body fish.**
- **Toxicity thresholds suggested by Brix et al. for warm water fish were 10 ppm for diet and 9 ppm for whole body fish.**
- **These thresholds can be compared to USDOJ “Substantive Risk” values currently in use which are >7 ppm for diet and >6 ppm for whole body.**

Literature Comparisons – Tissues

- NP fish whole body values were above or near the high end of Brix's thresholds in the early parts of the study and close to Hamilton's suggested minimum thresholds at the end of the study.
- NP fish diet, as represented Macroinvertebrate tissue levels, followed a similar pattern, although the data were limited.

Summary

- When we compare our early and mid-study data to the current UDOI guidelines for risk to wildlife, the data suggests the system was at substantial risk.
- After a two year period of flushing with non-risk level water, it appears that the aquatic wildlife in the Nature Preserve is currently at marginal to no risk.

Data Gaps

- **Dietary data for fish and birds is limited or non-existent.**
- **Additional macroinvertebrate data would be needed to fully evaluate fish dietary issues.**
- **Selenium concentrations in terrestrial insects could be collected that would provide potential bird dietary exposure levels for insectivorous birds.**
- **Additional top predator fish tissue would be needed to determine final steady state levels at the wetlands outfall.**

